

Claims

What is claimed is:

- 1 1. An apparatus that provides at least one estimated effective age of a
2 product, comprising:

3 at least one sensor that provides data about an environmental
4 condition;

5 a device that uses said data to calculate an age acceleration
6 factor for said product for at least one of said sensors;

7 at least one accumulator that provides the estimated effective
8 age for said product, based upon said age acceleration factor; and

9 a display capable of presenting said estimated effective age to
10 a user of said product.
- 1 2. The apparatus of claim 1, wherein said sensor includes an analog to
2 digital conversion function, and wherein said device that uses said
3 data to calculate an age acceleration factor is a digital processor.
- 1 3. The apparatus of claim 2, wherein said digital processor is
2 programmed to compute an Arrhenius estimate of said age
3 acceleration.
- 1 4. The apparatus of claim 2, wherein said digital processor is
2 programmed to compute a Coffin-Manson estimate of age
3 acceleration.
- 1 5. The apparatus of claim 2, wherein said digital processor is
2 programmed to compute a Hallberg-Peck estimate of age
3 acceleration.

- 1 6. The apparatus of claim 2, wherein said accumulator is at least
2 partially implemented in nonvolatile storage.
- 1 7. The apparatus of claim 6, wherein said nonvolatile storage is a
2 ferroelectric memory.
- 1 8. The apparatus of claim 6, wherein said nonvolatile storage is a flash
2 memory.
- 1 9. The apparatus of claim 6, wherein said nonvolatile storage is a hard
2 disk.
- 1 10. The apparatus of claim 6, wherein said nonvolatile storage is a
2 volatile memory element, with continuity of power provided by a
3 battery.
- 1 11. The apparatus of claim 1, wherein said sensor produces an analog
2 voltage output, said analog voltage output varying substantially
3 linearly responsive to a change in temperature.
- 1 12. The apparatus of claim 11, wherein said device that uses said data to
2 calculate an age acceleration factor for said product is a VCO, said
3 VCO producing a VCO output signal that varies substantially
4 exponentially responsive to a linear voltage change on an input of the
5 VCO.
- 1 13. The apparatus of claim 12, wherein said accumulator is a counter;
2 said counter being implemented, at least in part, in a nonvolatile or
3 effectively nonvolatile technology.
- 1 14. The apparatus of claim 13, wherein said display is electrically
2 coupled to selected bits of said counter.

1 15. A method for producing one or more estimates of effective age of a
2 product, comprising the steps of:

3 sensing one or more environmental conditions;

4 computing an age acceleration factor for each of the
5 environmental conditions sensed, using a model that relates the
6 environmental condition to the age acceleration factor;

7 computing effective age values, using said acceleration
8 factors;

9 storing said effective age values into nonvolatile storage; and

10 displaying said effective age values to a user of said product
11 on a display.

1 16. The method of claim 15, wherein the step of computing an age
2 acceleration factor comprises the use of the Arrhenius equation, the
3 Hallberg-Peck equation, or the Coffin-Manson equation.

1 17. The method of claim 15, wherein the step of computing effective age
2 values further comprises the steps of:

3 time integrating the age acceleration factor for each of the
4 environmental conditions sensed, resulting in an effective age for the
5 product according to each said model;

6 computing a normalized effective age for some or all of the
7 effective ages by dividing the instant effective age by a wall clock
8 age;

9 computing an effective life used value for some or all of the
10 effective ages by dividing the instant effective age by a
11 predetermined estimate of life of the product; and

- 12 computing an effective life remaining value for some or all of
13 the effective ages by subtracting said effective life used value from
14 "1".
- 1 18. The method of claim 15, wherein the step of displaying said effective
2 age values further comprises the steps of:
- 3 determining if any of said values are outside of predetermined
4 ranges; and
- 5 alerting the user if any of said values are outside of
6 predetermined ranges by lighting a light, sounding an audible alarm, or
7 presenting said values on said display